Lesson 3: Protecting Ocean Hotspots

Name: ______________________________ **Date:** ______________________

Engage

Think about the ocean and the seafloor.

1. Draw a sketch of what you picture when you think about the seafloor.

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Explore

2. When your teacher projects the Pacific Ocean map, observe it carefully. Describe what you see.

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Read the following:

The ocean is Earth's final frontier. According to NOAA, the ocean's average depth is 4.3 kilometers, which is 2.65 miles. This means that on average there are 4,300 meters, or over 14,000 feet, of water above the seafloor. This deep and flat area of the ocean is called the abyssal plain. Some areas, such as those along coastlines, are much shallower. There also are underwater mountains that stretch up from the abyssal plain towards the ocean surface. These features are called seamounts. The tops of seamounts can reach very close to the sea surface. Other areas are much deeper. The deepest spot in the ocean is the *Mariana Trench*, with a water depth of 6.8 miles or 10,924 meters, or over 35,566 feet.

Many organisms live in the ocean's deepest areas and on its surface, but scientists are still learning about them all. The description of the ocean's depth and seafloor features is called **bathymetry.**

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3. In the chart below, name, sketch, and describe each feature from the slides shared by your teacher.

Feature Name	Sketch	Description	Depth

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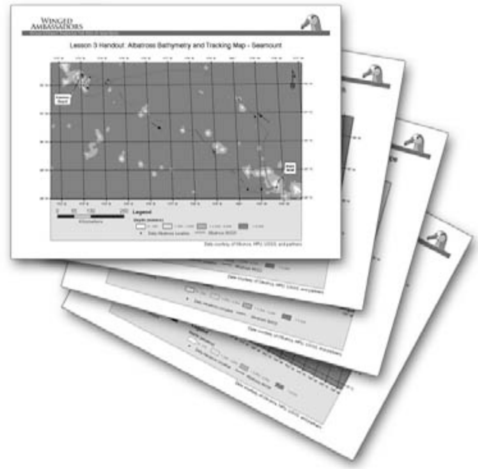

Use the ***Albatross Tracking and Bathymetry Maps*** provided by your teacher to answer the following questions.

4. What seafloor features can you observe on your map?

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5. Read the legend on your map and use it to identify areas of different depths. Refer back to your chart to help you. Label the following:

    a. Continental shelf
    b. Continental slope
    c. Abyssal plain

6. The dots on the map indicate noon locations of tracked Black-footed Albatross. Follow the directions for each step below, and record your findings in the data table.

    a. Count the total number of dots.
    b. Count the number of dots located in shallow water areas—on the continental shelf and continental slope.
    c. Count the number of dots located in deep water areas—over the abyssal plain.

7. The boxes on the maps you are using are 5 degrees by 5 degrees of latitude and longitude. Count the number of dots within 5 degrees of a seamount or bank. Record the number of dots in the second column.

Location Counts	**Number of Dots**	**Percentage of Time Spent**
Total		*100% (the total amount of time)*
Shallow Water		
Deep Water		
Near Bank or Seamount		

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8. Find the percentage of the total time that the albatross spent in both shallow water, deep water, and near seamounts/banks. Record each percentage in the data table.

   a. To calculate the time spent in shallow water:

$$\frac{\text{\# of dots in shallow water}}{\text{Total \# of dots}} = \text{\% of time spent in shallow water}$$

   b. To calculate the time spent in deep water:

$$\frac{\text{\# of dots in deep water}}{\text{Total \# of dots}} = \text{\% of time spent in deep water}$$

   c. To calculate the time spent near seamounts or banks:

$$\frac{\text{\# of dots within 5 degrees of seamount or bank}}{\text{Total \# of dots}} = \text{\% of time spent near seamounts/banks}$$

9. Did the albatross spend more time in shallow water, deep water, or near seamounts? Use your data to support your answer.

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10. How can you explain your findings? Why do you think albatross visit these areas?

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11. On your maps, circle any "**hotspots**" for your albatross. Hotspots are areas where an albatross spent a lot of time (multiple days) or that an albatross repeatedly visited.

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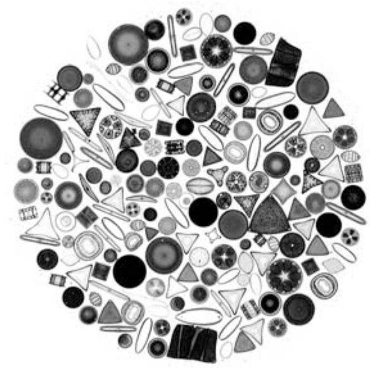
Explain

Ocean Productivity and Food



Diatoms are one of the most common types of phytoplankton.

You are now very familiar with seafloor features, such as seamounts and continental shelves and slopes. You have also identified areas that albatross visit over and over again. Seafloor features can affect how much food is available in different areas. Albatross take advantage of this.

Food provides both energy and nutrients. Imagine you are eating a cheeseburger with lettuce and tomato on a bun. In each bite, you are getting protein, carbohydrates, fat, vitamins (like Vitamins A and C) and minerals (like calcium and potassium). The food gives you the energy you need to do your life activities, like walking, breathing, and pumping your blood. The nutrients are used for life activities and to build body structures, including muscles and bones.

Both energy and nutrients can be hard to get in the ocean. Almost all of the energy available to ocean organisms comes from the sun. Tiny plant-like organisms called **phytoplankton** capture the sun's energy. They use the sun's energy to create sugar in a process called **photosynthesis**.

Phytoplankton make fats and oils. These compounds store the sugar, or chemical energy. Ocean grazers eat the sugars and fats, just like cows or grasshoppers eat plants on land. The grazers are then eaten by other predators, like squid and small fish, which receive the energy and nutrients. But, the sun only lights the top layer of the ocean (photic zone). Therefore, organisms living in deep water must travel to the surface to eat or get energy from the organisms living in the sunlit areas above them. Luckily for them, dead organisms and other waste (poop, skeletons) sink down. Deep ocean organisms eat these materials for their energy.

Like you, phytoplankton need nutrients for their life activities, including photosynthesis. Land plants, which also do photosynthesis, get their nutrients from the soil. Soil is made up of pieces of rock and broken-down plant material. The remains of living organisms are broken down by **decomposition**. Decomposition makes the nutrients in the dead organisms available in the soil. In the ocean, when organisms die, they sink deeper into the water. Decomposition happens in the deep water. That means that the nutrients become available where there is no sunlight. Remember, though, that phytoplankton live near the ocean's surface because they need sunlight. Therefore, the nutrients from decomposition are not available to them.

In certain areas of the ocean, however, deep water containing lots of nutrients is brought up to the surface, where phytoplankton live. This process is called **upwelling**.

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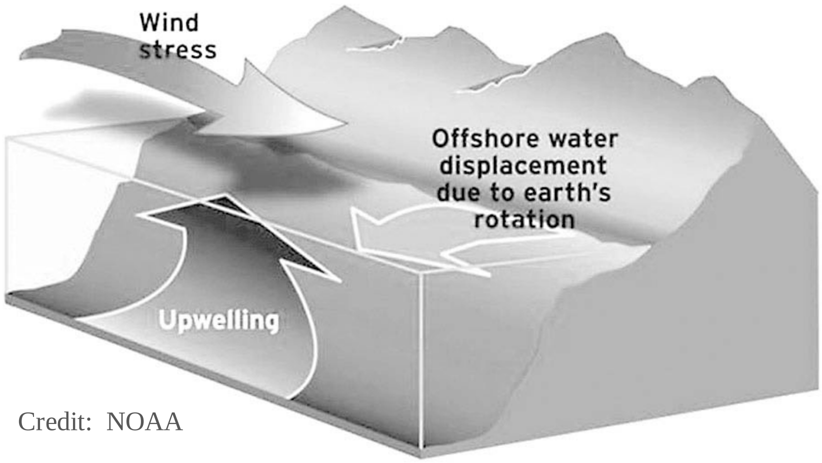

Credit: NOAA

Upwelling can happen for several reasons. Some upwelling is caused by the *makani*, the wind. When wind consistently blows parallel to a coastline, it pushes water away from the coast. This movement pulls up nutrient-rich water from down below (about 100 - 200 m deep) to replace the water at the surface. This type of upwelling occurs along the West Coast of the U.S. and many other coastlines. Water moves up the continental slope and onto the continental shelf. Upwelling can also happen in the open ocean, when deep-water currents encounter a seamount. Water flowing around a large obstacle, like an underwater mountain, will be pushed upwards and mix the nutrients into the surface waters. These are the two reasons why upwelling often happens near continental slopes and near seamounts.

Upwelling gives lots of nutrients to phytoplankton. These tiny organisms photosynthesize and reproduce very quickly. Phytoplankton are eaten by other organisms, which also get eaten by larger predators. Energy and nutrients are passed to organisms higher up the food chain, including *mōlī* (Laysan albatross), *koholā* (whales), and *honu* (sea turtles). Lots of phytoplankton means that lots of energy and nutrients are available to the ecosystem.

12. How might areas of upwelling affect albatross?

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13. Were the hotspots that you identified areas in which you would expect upwelling?

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Elaborate

Protecting Ocean Habitats

United States National Marine Sanctuaries and Marine Monuments are often compared with National Parks because they protect underwater treasures. These treasures include marine animal habitats and important cultural areas like shipwrecks.

National Marine Sanctuaries and Monuments are **marine protected areas** (MPAs). Creating MPAs is one of the ways in which we can care for, *mālama*, our ocean, *kai*. In our studies of albatross, we will focus on some of the sanctuaries and monuments in the Pacific Ocean.

14. Read the following passage, which introduces some of the Marine Protected Areas in the Pacific Ocean. In the data table, take notes about each.

Marine Protected Areas	Description of Location	Important Facts / Ideas

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U.S. National Marine Sanctuaries (NMS) and Marine Monument near the West Coast and Hawai‘i

Along the coast of Washington State is the **Olympic Coast NMS**, which protects lush kelp forests, deep water corals, and over 150 shipwrecks. The sanctuary covers over 3,000 square miles of ocean, and includes productive waters important for marine mammals such as sea otters and orcas, and seabirds including albatross and gulls.

The **Cordell Bank NMS** is named for a rocky habitat, or “bank”, that sticks up above the sandy seafloor. This bank is home to cold-water corals, algae, fish, and many other organisms. Marine mammals and seabirds, such as whales, seals and sea lions, murres, albatross and shearwaters, frequent this sanctuary to feed themselves and their young. The sanctuary protects 529 square miles of waters northwest of San Francisco.

Located near Cordell Bank and just beyond the city of San Francisco is the **Gulf of Farallones NMS**, named for its location near the Farallon Islands. The sanctuary protects several different ecosystems including wetlands, the open ocean and reefs, within it’s nearly 1,300 square miles of waters. Like Cordell Bank, the Gulf of the Farallones NMS is located in very productive waters that provide food for many seabirds and marine mammals.

Monterey Bay NMS covers over 6,000 square miles of ocean and is home to numerous marine mammals, seabirds, fish, plants, and invertebrates such as sea stars, anemones, and corals. It includes one of the largest kelp forests and near-shore underwater canyons in the United States. Also, it protects the Davidson Seamount, the only seamount inside a NMS.

In Southern California, one finds the **Channel Islands NMS**. This sanctuary protects the Santa Barbara Channel and areas surrounding the Channel Islands. Protected ecosystems include rocky intertidal, kelp forests, rocky reefs, sandy bottom and open ocean. Species include over 60 types of seabirds, many invertebrates, fish, and marine mammals. Channel Islands NMS protects 1,500 square miles of ocean.

The **Hawaiian Humpback Whale NMS** is found in the warm waters near the main Hawaiian Islands. It protects an important breeding ground for humpback whales, which are affected by human activities including collisions with boats, entanglement in fishing gear, noise pollution, and water quality issues.

North of the main Hawaiian Islands lies the Northwestern Hawaiian Islands, or, ancestral islands, of the **Papahānaumokuākea Marine National Monument** (pronounced Pa-pa-hah-now-mo-koo-ah-keh-ah). This Monument protects 140,000 square miles of the Pacific Ocean. Habitats protected include coral reefs, open ocean, and sandy beaches. Over 7,000 marine species make their homes within the Monument.

U.S. National Marine Sanctuaries protect ocean areas by limiting pollution, damage to coral and rocky seabeds, and some extractive activities such as oil drilling. The National Marine Monument can also restrict fishing and recreational boating. Papahānaumokuākea also protects important cultural areas for Native Hawaiians.

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Answer the following questions based on your data table:

a. Which is the largest national marine sanctuary or monument?

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b. Which national marine sanctuary or monument is most interesting to you? Why?

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Albatross are very vulnerable to human activities. These seabirds are often accidentally snared on fish hooks. They can also be tangled in fishing line. Other pollutants, including plastic trash and oil spills, can affect their nutrition and health.

15. Based on the albatross hotspots you identified, draw an area in which you would recommend creating a protected area specifically to protect albatross.

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16. Why would creating a national marine sanctuary to protect albatross be a challenge? What human activities might conflict with an area like this? Why?

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Evaluate

Return to your sketch in Question 1.

1. What do you think about this sketch now?

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2. Draw a new sketch of the seafloor, including features that you are now more familiar with. Label these features.

3. Which features might result in upwelling?

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